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(71) Applicant

Yasushi Nakashin,  
67—28 Isobe, chiba-shi,  
Japan

(72) Inventor

Yasushi Nakashin

(74) Agents

Haseltine Lake & Co.,  
Hazlitt House, 28  
Southampton Buildings,  
Chancery Lane, London,  
WC2A 1AT, England

**(54) Repairing underground pipes**

(57) An apparatus for repairing leaks in underground pipe comprises a carriage movable axially along the pipe, a flexible and stretchable tubular cover sheet surrounding a portion of the carriage, a plurality of power

driven back-up plates supported by the carriage and expandable radially to press the sheet into intimate contact with the internal wall surface of the pipe, and retractable radially for separating the sheet from the pipe wall, and a conduit inside the cover sheet for delivering group radially outwardly through the cover sheet.

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Fig. 1.

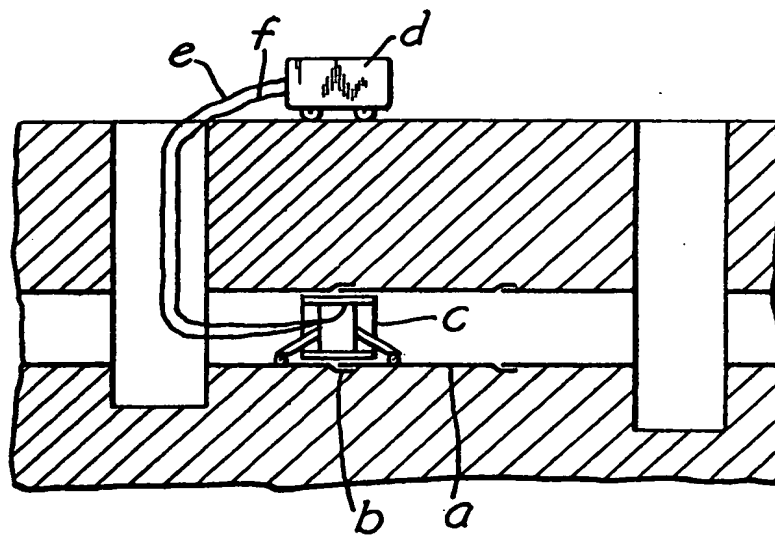
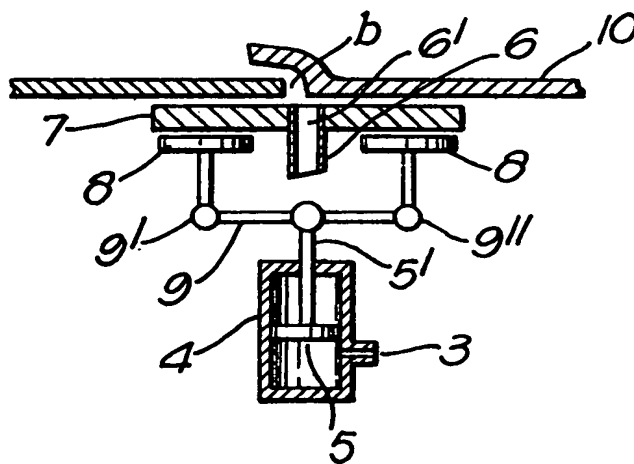


Fig. 4.





## SPECIFICATION

## Repairing underground pipes

The present invention relates to the repair of underground pipes and more particularly but not exclusively is concerned with an apparatus for repairing joints, cracks, or leaking points in an underground hollow pipe such as a water pipe, a sewer pipe, or a cable duct.

Underground pipe can generally be classified into three categories: 1) large diameter pipes which allow free access by a man and repair equipment; 2) medium diameter pipes which allow a man to enter such as by crawling, but which are too small to allow easy handling of equipment and repair; and 3) small diameter pipes which a man cannot enter.

In repairing a small diameter pipe such as in category 3) above, it is possible to employ a process such as is disclosed in Japanese Patent No. 929664 (laid-open publication No. SHO 49-118210). In this process, an expandable bag is inserted into the pipe and is pneumatically inflated to bring the bag into firm contact with the inside wall of the pipe. Thereafter, a hardenable chemical (grout) is poured between the pipe and the bag through an aperture in the bag to seal the leak.

In repairing large diameter pipes as described above in category 1), a worker can manually place an annular rubber sheet into engagement with the pipe wall and the sheet can be pressed (expanded) into engagement with the pipe wall by manually operated jacks. Thereafter, the hardenable chemical (grout) is poured through an opening in the sheet to seal the pipe leak.

The difficulty has arisen with respect to repairing leaks in the medium size pipes described above in category 2). Thus, in that category pipe, it is dangerous to utilize the pneumatically expandable bag described above for category 3). The large amount of high pressure air required for inflating the bag in this environment stores up an enormous amount of potential energy which, if the bag breaks, can result in an explosive air flow. Also, difficulties arise in attempting to align the grout opening through the bag with the pipe leak location. The technique described above for the large diameter pipes, category 1), also is not particularly useful for the medium diameter pipes because of the confined area inside these pipes and the requirement that the jacks be manually actuated.

The present invention is directed towards the provision of an apparatus which is capable of quickly and efficiently carrying out repair of leaks in underground pipes of a medium size, i.e. pipes which allow entry of a man but which are relatively confining.

Accordingly, the present invention provides a repair apparatus for repairing leaks in underground pipe or the like comprising:

- a movable carriage adapted to enter and be displaced axially along said pipe;
- a flexible and stretchable tubular cover sheet surrounding at least a portion of said carriage and

65 adapted to be brought into intimate contact with the internal wall surface of said pipe to cover the leaking part thereof;

a plurality of back-up plates supported by said carriage and expandable radially for pressing said sheet against the internal wall surface of said pipe and retractable for separating said sheet from said wall;

a power-driven mechanism supported by said carriage for actuating said back-up plates; and a conduit inside said cover sheet and adapted to deliver grout radially outwardly through the approximate axial centre of said cover sheet.

The apparatus of this invention is believed to be safe in operation and results in a proper and complete seal of the pipe leak. The apparatus of this invention is also useful in the repair of leaks in large diameter pipes and increases the efficiency and effectiveness of that operation.

The accompanying drawings which are by way of example illustrate one embodiment of the invention and, together with the associated description, serve to explain the principles of the invention. In the drawings:

FIGURE 1 is a schematic view showing the apparatus of the present invention in use in repairing a leak in an underground pipe;

FIGURE 2 is a longitudinal cross sectional view of the pipe repair apparatus of the present invention shown in position in a pipe;

FIGURE 3 is an end view of the structure of Figure 2; and

FIGURE 4 is a schematic view showing the relationship of parts of the structure of this invention.

There is depicted in Figure 1 an underground pipe *a* having a joint *b* at which there is a leak. Repair apparatus *c* constructed in accordance with the present invention is shown in position with the pipe at joint *b*. The repair apparatus *c* is connected by means of pressurized fluid pipe *e* and grout pipe *f* to a pump station *d* which is above ground.

In accordance with the present invention, the repair apparatus comprises a movable carriage adapted to enter and be displaced axially along the pipe. As embodied herein and shown in Figures 2 and 3, a carriage including a cylindrical shaped cylinder block 4 has a pair of supporting legs 2 extending from the front and from the rear thereof. Each of the supporting legs 2 has a caster 1 at its base. The legs 2 of each pair angle outwardly away from each other (Figure 3) so that the casters 1 can engage the inside wall surface of a pipe 10. The carriage is therefore movable axially along the pipe 10 after being positioned therein such as manually by a man within the pipe 10.

In accordance with the present invention, a flexible and stretchable tubular cover sheet surrounds at least a portion of the carriage and is adapted to be brought into intimate contact with the internal wall surface of the pipe to cover the leaking part thereof. As embodied herein and shown in Figure 2, a tubular cover sheet 7 surrounds a central portion of the carriage. The cover sheet 7 is constructed of a rubber or rubber-

hardened, the pressure through the hose 3 to the cylinder block 4 is released and the pistons 5 are retracted as described above. This causes the back-up plates 8, 8' also to retract radially and the cover sheet 7 to separate away from the internal wall surface of the pipe 10. The carriage can then be moved to the next joint to be repaired or can be withdrawn from the pipe 10.

#### CLAIMS

- 10 1. A repair apparatus for repairing leaks in underground pipe or the like comprising:
  - a movable carriage adapted to enter and be displaced axially along said pipe;
  - a flexible and stretchable rubular cover sheet surrounding at least a portion of said carriage and adapted to be brought into intimate contact with the internal wall surface of said pipe to cover the leaking part thereof;
  - a plurality of back-up plates supported by said carriage and expandable radially for pressing said sheet against the internal wall surface of said pipe and retractable for separating said sheet from said wall;
  - a power-driven mechanism supported by said carriage for actuating said back-up plates; and
  - a conduit inside said cover sheet and adapted to deliver grout radially outwardly through the approximate axial centre of said cover sheet.
- 20 2. A repair apparatus according to claim 1, wherein said cover sheet is formed of rubber or a rubber-like material.
- 30 3. A repair apparatus according to claim 2, wherein said cover sheet is constructed of an outer layer having a thickness of from 10 to 20 mm and a hardness of from 30 to 40 Shore hardness units, and an inner layer having a thickness of from 10 to 20 mm and a hardness of from about 40 to about 50 Shore hardness units.
- 40 4. A repair apparatus according to claim 1, 2 or 3, wherein said back-up plates are annularly

arranged around the interior of said cover sheet.

5. A repair apparatus according to claim 4, which further includes link means connecting each adjacent set of axially spaced back-up plates, and wherein said power-driven mechanism including means connected to each respective link means.

6. A repair apparatus according to claim 1, 2, 3, 4 or 5, wherein said back-up plates comprise a plurality of pairs of back-up plates which are annularly arranged in two rows axially spaced at the approximate axial centre of said cover sheet.

7. A repair apparatus according to claim 6, wherein said back-up plates overlap with adjacent ones in each row.

8. A repair apparatus according to claim 6, wherein said back-up plate rows are spaced a distance of about 20 mm.

9. A repair apparatus according to any preceding claim, wherein all said back-up plates are adapted to be actuated in synchronization.

10. A repair apparatus according to claim 9, wherein said power-driven mechanism comprises a piston and cylinder means connected to each of said pairs of back-up plates and actuated from a single fluid pressure source.

11. A repair apparatus according to any preceding claim, wherein said movable carriage is provided at the front and rear ends thereof with a plurality of legs for supporting the power-driven mechanism, said back-up plates, and said cover sheet surrounding the middle portion of said movable carriage.

12. A repair apparatus substantially as hereinbefore described with reference to, and as illustrated in the accompanying drawings.

13. A method of repairing an underground pipe, in which there is used a repair apparatus as claimed in any preceding claim.

14. A method of repairing an underground pipe, substantially as hereinbefore described with reference to the accompanying drawings.